30 AND 1000*

HOW TO BUILD A KNOWLEDGE-BASED ECONOMY IN MAINE AND RAISE INCOMES TO THE NATIONAL AVERAGE BY 2010

***30% OF MAINE'S ADULTS WITH 4-YEAR COLLEGE DEGREES**
$1000 OF R&D PER WORKER

November, 2001

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OVERVIEW: WHAT "30 AND 1000" MEANS TO OUR ECONOMY

The State Planning Office has reviewed 10 years of data for all 50 states and correlated that data with per capita incomes. The results:

> Two factors go a long way in explaining the differences in per capita incomes among the 50 states:
>
> 1. Percentage of adults (25 and older) with at least 4-year college degrees, and
>
> 2. The dollars per employed worker in the state spent on research and development.

Nothing could make it clearer that the nation's economy is now knowledge-based.

What's more, the correlation between these factors and per capita income is strong enough to yield predictions. If Maine improves its performance in these two factors, what will it get us in terms of improved per capita income? The answer:

30% of adults with 4-yr. degrees	**and**	**$1000 per worker[1] spent on R&D**	**produces $28,000 per capita income**

How does that compare with recent (1998) experience in Maine?

19%[2] of adults with 4-yr. degrees (46th in the nation)	**and**	**$ 255[3] per worker spent on R&D (44th in the nation)**	**produced $23,529[4] per capita income (37th in the nation)**

This is the basis of the 30/1000 campaign: increase the percentage of Maine's adults with 4-year college degrees to 30%, and increase the amount of R&D spending (by all parties, from all sources) to $1,000 per employed worker in the state. If we do, *we will, once and for all, raise our per capita income to the national average or above*. Climbing toward and hitting these thresholds will release economic activity that leads to widespread prosperity in our new economy.

Conversely, if we don't work toward these thresholds, there is almost no other combination of things that will raise Maine's per capita income to this level. Regardless of what else we do, our incomes will lag.

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[1] In projected 2001 dollars; the actual figure derived from the regression analysis is $1,035 per employed worker. We will use $1,000 as an easy-to-remember surrogate.
[2] Source: U.S. Census, 1998 data
[3] Source: Maine State Planning Office, using 1998 R&D data from National Science Foundation and 1998 labor data from the Maine Department of Labor. Data were unavailable for one state.
[4] Source: US Bureau of Economic Analysis, 1998 data

I. MAINE'S ECONOMY 10 YEARS FROM NOW

Enjoying the returns of a knowledge-based economy:

- population, growing at 0.5% to 1.0% per year, in livable small towns and vital cities
- amidst a spectacular natural and working landscape
- with good per capita incomes
- driven by innovation in traditional and new industries
- and by high-end manufacturing.

II. BOILING IT DOWN TO A MEASURABLE GOAL

Raise Maine's per capita income to the national average by 2010. Maine chronically lags the nation by 12% to 15%, placing us 37th in the nation in per capita income. The difference costs each Mainer about $2,300 per year, each household an average of close to $6,000 per year, and the state's economy about $3 billion per year.

Where we are today (per capita income)

Maine (1999)	$24,603
United States (1999)	$28,542

To reach the national average, Maine's per capita income will have to increase at an average rate that is *one to one-and-a-half percentage points greater* than the rate of increase nationally, each year for the next decade. If the nation's per capita income increases by 5% per year over the next decade, Maine's must increase by between 6% and 6.5% per year.

III. WHAT MAINE ALREADY HAS DONE

The last several years have been active in building Maine's knowledge-based economy. **Progress has been made at all levels of education**:

- In K-12, adoption of *Learning Results* and the beginnings of a Technology Endowment Fund; high scores on national, standardized tests; high rates of graduation from high school

- Establishment of a Community College, cooperatively implemented by the Technical College System and the University of Maine System, to ease access into higher education

- Major capital investments totaling $26 million at all Technical College campuses

- An initial investment for capital improvements at Maine Maritime Academy, where a technology forecasting program has been instituted

- Resumed growth in enrollment in the University of Maine System

Investments in research and development are growing. Recognizing its central role in the economy, the Legislature and Governor have raised R&D high on their agendas. In November 1998 voters approved a $20 million referendum for R&D. The Maine Science and Technology Foundation published a Science and Technology Report Card to help us assess investments in targeted sectors as well as an evaluation procedure. The Legislature established a Joint Select Committee on Research and Development, which led to nearly $19 million of ongoing investments in R&D, beginning in FY 2000, including:

- $10 million per year for the University of Maine System's Economic Improvement Fund
- $2.5 million per year to support University borrowing for R&D facilities
- $6.4 million for the new Maine Technology Institute to provide grants to companies and labs for ideas leading to commercialization

In addition, this year the Legislature and Governor approved one-time funding for the following education and research related activities:

- $10 million appropriation for biomedical research at the state's nonprofit bio-medical research laboratories
- $5.5 million for advanced technology centers which are to be business incubators for start-ups in targeted technologies ($500,000 is ongoing)
- $17.4 million for technology and facility upgrades at University of Maine System campuses
- $3 million for the Small Enterprise Growth Fund which provides Maine entrepreneurs with access to venture capital

- $3 million for the Maine Venture Capital Revolving Investment Program which reinvests, through private venture capital funds, in promising young Maine companies.
- An increase from 30% to 40% in the Maine Seed Capital Tax Credit Program which will invigorate "business angel" investing in early-stage Maine businesses.
- $50 million for the Maine Learning Technology Endowment to provide learning technologies to elementary and secondary students
- $300,000 to establish the Maine Patent Program at the University of Southern Maine

The Legislature also approved changed to the Economic Recovery Loan Program that allows the state to take more risk by using "equity kickers" via warrants for stock, royalties or other means. This allows a traditional debt program to work with early-stage or mature businesses to propose investment in new technology or product developments that are not suitable for traditional debt structures.

And in June 2000 a consortium of the Bigelow Laboratory for Ocean Sciences, the University, nonprofit groups, businesses, and state agencies received $6 million from the Office of Naval Research to launch a key piece of marine research infrastructure, the Gulf of Maine Ocean Observing System.

Outside of state government, **many private organizations that conduct research are advancing**. Several research laboratories – Maine Medical Center Research Institute, The Jackson Laboratory, Bigelow Laboratory for Ocean Sciences, the Mount Desert Island Biological Laboratory, the Foundation for Blood Research, and nascent labs at the Gulf of Maine Aquarium Research Center and the University of New England – are expanding facilities and/or establishing new programs.

Private companies in the state's seven targeted technologies (e.g., information technology, biotechnology, environmental technology, composites & advanced materials, aquaculture and marine technology, advanced technologies in forestry and agriculture, and precision manufacturing technology) are investing in R&D and the search for new products and technologies. The breadth of their work is reflected in the first round of grants worth $3 million from the Maine Technology Institute which leveraged $4.8 million in other investments. And the Maine Manufacturing Extension Program assists manufacturers of all vintages with the transfer of technology and has become a national center for the administration of similar programs in other states.

R&D by private firms is assisted by a series of state tax credits enacted over the last 5 years, including an R&D Expense Credit, a Super R&D Tax Credit, a High Technology Tax Credit (for the information technology industry), and an R&D sales tax exemption.

The Maine Science and Technology Foundation has launched a web-based S&T clearinghouse and will publish a new Science and Technology Plan in January, 2001.

Finally, Dr. Richard Florida of Carnegie-Mellon University, KMPG and others have documented **the relationship between the “quality of place” and the knowledge-based economy**. People in a knowledge-based economy have choices as to where to put down roots, and they are increasingly choosing regions that have a high “quality of place” – healthy environments, vital communities, openness to people of different backgrounds, and easy access to the outdoors. Maine’s natural environment and investments in the Land for Maine’s Future, downtowns and “smart growth,” trail systems, and public access to water are putting it in good stead.

IV. WHAT IS STILL TO BE DONE TO GET TO 30 AND1000 AND HIGHER PER CAPITA INCOME

The good news, then, is that we have a foundation upon which to build. Many of the ventures described above are too new for governmental reports to have caught up with them. But to get to 30 and 1000 and higher incomes,

- **the share of our adult population with at least bachelor's degrees will have to increase by half**, from 19% as of 1998 to 30%, including perhaps 10% with advanced degrees. This means adding more than 100,000 adults with degrees over the next decade, or more than 10,000 per year; and

- **R&D investments from all quarters must increase more than 4-fold**, from less than $200 per employed worker as of 1998 to $1,000 per employed worker in 2010.

To reach the goal, ***we have to aggressively build a knowledge-based economy.*** That requires four things:

1. Knowledge workers;
2. Knowledge-generating institutions, in particular a tier-one research university or a consortium of institutions (universities, research laboratories, teaching hospitals) that has the equivalent economic impact of one;
3. A business climate (offering good education, a fair tax system, access to University expertise, infrastructure, and financial and technical assistance) that invites industry to invest in R&D; and
4. A high quality of place that attracts and retains knowledge workers.

See **Appendix** for further documentation of the importance of a knowledge-based economy to the incomes of a state.

"Knowledge workers" are scientists, software programmers, engineers, mathematicians, researchers, technicians, managers, marketers, investors, and others who innovate: who create knowledge or use knowledge to create new products, processes, and services. Through innovation – developing new technologies and products and bringing them to market – they help drive a region's economy. They tend to work in "high technology" or "knowledge-intensive" industries, including both new industries (software, biotechnology, composites, etc.) and traditional industries that have converted to leading edge technologies (paper, aquaculture, shipbuilding, etc.)

"Knowledge-generating institutions" are the economic engines of the knowledge-based economy. Whether in the private or public sector, they do not simply share or transfer knowledge. They **create** it, usually through intensive R&D. They include research universities, private nonprofit and for-profit laboratories, R&D divisions of industry, governmental labs, teaching hospitals, and similar organizations.

V. HOW TO GET THERE: SUMMARY OF OUTCOMES AND KEY ACTIONS

Goal

Raise Maine's per capita income to the national average by 2010

Objectives: 30 and 1000*

* 30% of Maine's adults with college degrees, and $1,000 of R&D spending per worker

Outcome 1
Create, Retain & Attract Knowledge Workers

Increase the number of "knowledge workers" in Maine through education and attraction of talent.

How we will measure this

- Increase the percent of Maine's adults with high schools diplomas from 89% in 2000 to 92% by 2005
- Increase Associate degrees from 2,400 to 3,500 per year and Bachelor degrees from 6000 to 9000/year, incl. S&E Bachelor degrees from 900 in 1996-97 to 1,200 per year by 2010
- Increase recent S&E graduates in Maine's workforce from 9,900 in 1996-97 to 20,000 by 2010.

Actions: p. 10-12

Outcome 2
Conduct World Class Research

Create the equivalent of a tier-one research university through alliances between and among the University of Maine System and the state's nonprofit research labs.

How we will measure this

- Increase total spending by these institutions from $88 per employed worker in Maine to $200 per employed worker.

Actions: p. 12-14

Outcome 3
Create New Products & Services

Clear away barriers and provide incentives to encourage investment by industry in research and development

How we will measure this

- Increase R&D spending by industry from $1309per employed worker in Maine to $835 per employed worker.

Actions: p. 14-15

Important to Note:

1. The following actions support and help implement **Maine's Science and Technology Plan.**
2. They complement (in some cases they borrow from) the **University of Maine System's "The Maine Idea."**
3. This action plan assumes, and therefore does not repeat here, that a number of initiatives already underway and needed to achieve "30 and 1000" will continue to be executed. These include: **Learning Results,** the **Community College,** the **Governor's Training Initiative**, the **Technology Endowment for Schools**, and the **Advanced Technology Centers** (incubators)**.**
4. National research has found that **"quality of place"** is a prerequisite to a region's success in the new economy. It is one of the magnets that attract and keep talent. The "quality of place" sought by the new generation of knowledge workers can be described as
   - vital small towns and urban centers with "thick" opportunities for work and multiple opportunities for recreation,
   - surrounded by an outstanding natural landscape,
   - welcoming of people of many backgrounds, and
   - with housing and lifestyles within reach of people at different incomes and stages of careers.

These also are the goals of "smart growth." This action plan therefore assumes that Maine will remain committed to "smart growth" and related investments in the state's service centers, downtowns, farms and forests, and the Land for Maine's Future.

Actions to support Outcome #1:
Increase the number of "knowledge workers" in Maine through education and attraction of talent.

Measure	Activity	Lead	Fiscal Note
1-1 Increase High School diploma rate from 89% in 2000 to 92% in 2005	Create **Governor's Academy for Science and Mathematics Education** – target 120 distinguished K-12 math and science teachers to initiate and sustain educational reform in math and science.	DOE	$75,000 per year
	Address **shortage of teachers** in math, science, and technology. Recommendations from DOE, UMS, Legislature due early in 2001**.**	DOE & UMS	Not yet available

1-2 Increase associate degrees from 2400 to 3500/yr; 4-yr. college degrees from +/- 6000 to +/- 9000 /yr., incl. science & engineering degrees from +/-900 to +/- 1200/yr.	Increase **student aid** for higher education		
	▪ Through MSISP, increase need-based scholarships for Maine students, both full- and part-time, attending Maine institutions. Increase both amount of aid per student and no. of students.	FAME	$3 million/year
	▪ Through endowment, expand institutional-based aid programs at UMS (and MMA and Technical Colleges if they wish to embark on private fundraising for this purpose).	UMS/MMA/ Technical Colleges	$10 million plus $10 million external match (yielding $1 million per year in aid) – 1 time
	Expand **college student and teacher internships** through the Maine Research Internships for Teachers and Students Program (MERITS). Add +/-50 undergraduates and teachers in FY 2001-2002.	MSTF/MERITS	$100,000 per year
	Make Maine's **graduate fellowships & assistantships** nationally competitive. Illustratively, fellowships at $16,000 per year, graduate research assistantships at $10,000 plus tuition. Create some at nonprofit research labs.	UMS	$300,000 per year
	Implement **Transition U.** as a vehicle for the incumbent work force to return to higher education.	DOE/DOL	$1.2 million /$2.0 million per year
	Form an **Ad Hoc Task Force on Higher Education** outside of state government and the university system where those most concerned with the fate of post-secondary education in Maine – business leaders, government officials, students, educators – can work constructively together.	MDF	Private fundraising
1-3 Increase science and engineering graduates in the workforce from 9900 to 20000.	Model after the Educators for Maine Program a **program to forgive or repay loans for graduates** (in or outside of Maine, any degree level) who choose to work in Maine in one of the targeted technology areas. Up to $5,000 per year for 3 years, matched by the employer. Sliding scale depending on size of employer. Must work in Maine at least 3 years following graduation.	FAME	$1 million/year plus $1 million private match
	Expand **graduate degree programs at USM**. In particular, establish a clear plan and implementation schedule for offering advanced degrees in biosciences, information sciences, and business.	UMS/USM	$100,000 planning grant – one-time

			OUTCOME #1: **TOTAL STATE FUNDS** Ongoing: FY 2002 $5,775,000 FY 2003 $6,575,000 One-time: FY 2002 $10,000,000

Actions to support Outcome #2:

Create the equivalent of a tier-one research university through alliances between and among the University of Maine System and the state's nonprofit research laboratories.

Measure	Activity	Lead	Fiscal Note
2-1 Increase R&D Spending by Universities and Nonprofit Research Labs to $200 per Worker (2001 dollars) **Note: this will bring total R&D spending by these institutions to $130 million - $140 million per year, compared to $66 million in 1998.**	Strengthen **R&D at Maine's principal knowledge-generating institutions**, the University of Maine System and 5 existing (plus 2 emerging) nonprofit research laboratories: ▪ Over the next two biennia, increase State investments in R&D at the UMS by $10.0 million per year (bringing the total to $22.5 million per year). ▪ Over the next two biennia, base fund R&D at nonprofit research labs (5 existing, 2 emerging) at $10 million per year. ▪ In each case, require leveraging of at least $4 for each $1 of state funds. Condition funds on cooperative arrangements between the UMS and labs to position the whole as a tier 1 research university.	UMS, nonprofit labs, DECD (admin. grants to labs)	FY 2002/2003 biennium: Add $2.5 million/yr. to UMS Economic Improvement Fund and $2.5 million to UMS debt service for R&D capital facilities; base fund research labs at $5 million/yr. FY 2004/2005 biennium: Add $5 million/yr .to UMS Economic Improvement Fund; add $5 million/yr for labs.
	Establish the **Virtual Maine Biomedical Research Institute**: Link the University of Maine System with the state's nonprofit research labs **to create the equivalent of a Tier One Research University**, with access to the world's largest single source of R&D		$1.25 million FY 2002 $2.5 million FY 2003

	funds: the National Institutes of Health. The Institute will focus on use-inspired basic and applied research and related graduate level education. The biomedical focus will allow the intersection of biotechnology with other of the state's targeted technologies, including marine science, advanced materials, and information technology. The goal is for Maine to become a world leader in these selected technologies, and to build and attract the talent needed to drive innovation and the economy. The Institute will be **based in the University of Maine System and report to the Office of the Chancellor**. Its graduate degrees will be issued by participation universities in the UM System**. Operating units known as Centers of Excellence** will carry out the research that will be the hallmark of the Institute. The centers can be located at any of the participating institutions (universities or labs), which will provide space and lend use of equipment. **Each center will specialize in an aspect of biomedicine where biotechnology intersects with a related field**: biotechnology and genetics (genomics); and marine science (marine biomedicine); and information technology (bioinformatics); and advanced materials (biophysics, bioengineering, biomaterials). At these centers, faculty will be joint appointments of the university and research lab(s), and graduate students will benefit from contact with labs and scientists in both university and private sector settings. In time, 5 or more centers may be designated. For the next biennium, funds are proposed for two, to be determined competitively by the Institute's board of directors and participating institutions. **See Appendix C for more complete description.** Recapitalize the successful **Marine Technology Fund** to respond to high quality demand for applied marine technology R&D.	 MS&TF	 $3 million, one-time

	Track performance of expanded R&D effort. **Annually assess research needs and opportunities** among UMS, nonprofit research labs, and firms across the state, and convene high-level colloquium to lay plans for meeting the needs.		$50,000/yr. **OUTCOME #2, TOTAL STATE FUNDS** Ongoing: FY 2002 $11,300,000 FY 2003 $12,550,000 One-time: FY 2002 $ 3,000,000

Actions to support Outcome #3:

Clear away barriers and provide incentives to encourage investment by industry in research and development.

Measure	Activity	Lead	Fiscal Note
3-1 Increase R&D Spending by Industry to $835 per Worker (2001 dollars) **Note: this will bring total R&D spending by industry to $575 million - $600 million per year, compared to $82 million in 1998.**	Articulate and codify a coherent vision for R&D. This could embody a **5-year commitment to the Legislature's Select Committee for R&D** so that R&D has an advocate within the legislative branch. Increase by $2 million in FY 2002 and 2003 state matching funds, through the **Maine Technology Institute**, for the commercialization by industry of new technologies, products, and services. This would bring MTI's annual allocation by the State to $8.4 million per year, en route to a long-term commitment to build to $15 million per year. ▪ Use a portion of the additional funds for **R&D vouchers**, with which a small company initiates a partnership with a university, college, or technical college based on its needs. MTI provides vouchers (e.g., $75,000 per year for up to 3 years, match required) on a competitive basis to qualified firms, who can then shop the vouchers among faculty and institutes at any college or university in the state.	Legislature MTI, DECD	Within existing resources $2 million per year, plus $2 million match by industry

	Take Maine's two existing research tax credits for industry (Research Expense Credit and Super R&D Credit) to the next logical step by **extending the credit to the production of goods and services that are a direct result of the research** for which the original credit was granted. For example, if a company has qualified to receive from Maine a Research Expense Credit or Super R&D Credit, and if one of the research ideas reaches the stage of commercialization in Maine, and the commercialization in fact occurs in Maine, the original credit could be repeated for each of the first three years of production in the state. Develop a **strategy to grow industry clusters** – Maine's best hope to create the "thick" labor markets talent workers require. DECD, in consultation with industry and Maine Science and Technology Foundation and in conjunction with its incubator program, should develop an explicit strategy for consideration in the 2nd session of the 120th Legislature. It should include consideration of connections to and extensions of Boston-based clusters into southern Maine. Provide ongoing support to the **Maine Patent Program**, administered by the Technology Law Center at the University of Maine Law School, at least until royalties in return for services can make the center self-supporting.	Maine Revenue Services, DECD DECD, MS&TF, Legislature USM, Technology Law Center	This and similar ideas continue to need to be reviewed with Maine Revenue Services, DECD, and industry. Aim for introduction of an entrepreneur's tax credit in the second session of the 120th Legislature. Fiscal note not yet known. Within existing resources $300,000 per year **OUTCOME #3, TOTAL STATE FUNDS:** Ongoing: FY 2002 $2,300,000 FY 2003 $2,300,000 (plus foregone revenues of extending R&D tax credit to production)
			GRAND TOTAL STATE FUNDS: Ongoing: FY 2002 $19,375,000 FY 2003 $21,425,000 One-time: FY 2002 $13,000,000

APPENDIX A
THE IMPORTANCE OF A KNOWLEDGE-BASED ECONOMY TO PER CAPITA INCOMES

We live in a knowledge-based economy. It rewards those who innovate and penalizes those who don't. The penalty is chronically low average incomes.

Two factors especially mark this economy: college graduation rates and investments in research and development.

Percent of adults with at least a 4-year college education is perhaps the most important variable in explaining the variation in per capita incomes among states. By itself, it accounts for 51% of the differences among the 50 states. States with small percentages of adults with college degrees almost always have below average incomes.

R&D is also one of the important drivers of the knowledge-based economy. In 1998:

Of the 10 states with the **highest** R&D expenditures (average 4.6% of gross state product),
- 7 had per capita incomes **above** the national average;
- these 10 states' per capita income was $29,011.

Of the 10 states with the **lowest** R&D expenditures (average 0.4% of gross state product),
- 10 had per capita incomes **below** the national average;
- these 10 states' per capita income was $22,634.

This isn't coincidence. 26% of the variation in per capita incomes in the 50 states is explained solely by the differences in R&D expenditures as a percent of gross state product.

Combined, these two factors (percent with a college education and total R&D expenditures expressed either as percent of GSP or as dollars per

WHERE MAINE STANDS

Maine is among the states with small percentages of adults with college degrees. In 1998, Maine's rate was 19.2%, vs. a national average of 24.4%. In New England, the state with the next smallest percentage was New Hampshire, with 26.6%. Massachusetts was at the top of New England states, and in the top five nationally, with 31.0%.

Maine also was in the lowest group of states in R&D expenditures. R&D expenditures in 1998 were 0.46% of GSP, vs. an average of 2.26% nationally. Among New England states, the next lowest was Vermont at 1.05% of GSP.

Based on these two factors – low college graduation rate and low R&D expenditures – **it is entirely predictable** that Maine's per capita income in 1998 was well below the national average: $23,500 vs. $27,300. Even Vermont, which is smaller and more rural than Maine, and whose largest city is half the size of Maine's largest city, had a per capita income almost $1,300 higher than Maine's.

employed worker) account for **57% of the variation** in per capita incomes across the U.S. The two variables are significantly related; one tends to accompany the other. But it is hard to say which comes first; they probably feed off each other and need to be concurrent.

Performance by industry is most important in the R&D - income equation, but by itself may be insufficient to push incomes above average. R&D expenditures **by industry *and* universities and research labs** increase the likelihood of higher incomes.

- States without significant R&D expenditures by industry have low average incomes. Of 17 states with R&D expenditures by industry less than 1% of GSP, 16 have **below average** per capita incomes.*

- Of the 32 states with industry R&D expenditures more than 1% of GSP, just under half have per capita incomes **above the national average**.

- As of 1998, the latest years for which complete figures are available, Maine was in the lowest ranks of R&D spending for all categories except nonprofit labs.

Natl. av. R&D expenditures
as percent of gross state product (1998):
2.26% total, including
1.86% by industry
0.29% by universities
0.27% by federal labs and agencies
0.03% by nonprofit labs

Maine (1998)
0.46% total, including
0.25% by industry
0.11% by universities
0.00% by federal labs and agencies
0.10% by nonprofit labs

* Data for one state, Alaska, were not available for 1998

APPENDIX B

THE IMPORTANCE OF A FIRST TIER RESEARCH UNIVERSITY TO A KNOWLEDGE-BASED ECONOMY

Experience shows that research universities are among the nation's most important knowledge-generating institutions. They have long been important to a region's or state's economy, but today they have emerged as cornerstones of the New Economy.

A research university is one that offers a full range of baccalaureate programs and is committed to graduate education through the doctorate degree. According to *The Rise of American Research Universities* (1997), in the U.S. are 203 research universities: 131 public and 72 private. A "tier one" research university has high per faculty competitive federal grants and publications in leading journals. **Examples of tier one public research universities** are Michigan (Ann Arbor), UCal San Jose, UCal Berkeley, Texas (Austin), SUNY Stoney Brook, Indiana (Bloomington), Wisconsin (Madison), and Boston.

Maine's flagship public university, the University of Maine, is a research university but typically has been in the lowest tier nationally (104th out of 131 public research universities, according to one ranking). New investments and commitments by the university system and the state over the last 4 years are improving that. The investments also are benefiting the University of Southern Maine, which isn't a research university but is strengthening specialized areas of research.

Returns are beginning to show, with state dollars leveraging other funds at a 5:1 ratio, 11 patents filed over the last 3 years, and several business startups. Twenty-two UM researchers reportedly are interested in starting new business ventures. In 2000 the University of Maine System broke the $40 million mark in external research funding for the first time in its history. Both morale and entrepreneurialism among university PIs are on the rise.

At the same time, the university faces some limiting factors. Without a medical school, associated strengths in life sciences, and the related entree to the National Institutes of Health, it is unlikely that, as measured by federal grants, the system by itself will rise to the upper tier of research universities.

This is where Maine's remarkable group of independent nonprofit research labs step in. Maine has five such labs (The Jackson Lab, Maine Medical Center Research Institute, Bigelow Laboratory for Ocean Sciences, Foundation for Blood Research, Mount Desert Island Biological Laboratory), and two more are under development (Gulf of Maine Aquarium Research Center and University of New England's Marine Mammal Research Center). They are important knowledge-generating institutions. Four of the five existing labs are **strong precisely in an area in which the university system is weak:**

> **In 1998 Maine's nonprofit labs** accounted for over 5 R&D dollars spent in Maine -- a ratio that is almost twice similar labs in the next closest state (Hawaii) and 10 times higher than the national average. Led by The Jackson Lab, they account for most of the NIH funds that flow into Maine.

biomedicine, with proficient access to the National Institutes of Health. The fifth is renown for marine research.

The presence of these labs, in combination with a stronger university, can create the knowledge-generating and economic equivalent of a first tier research university -- without which Maine is unlikely to succeed in a knowledge-based economy.

Appendix C, which follows, presents a strategy for linking the University of Maine System and the nonprofit research labs into a “virtual” first tier research university.

APPENDIX C

A PROPOSAL TO ESTABLISH A VIRTUAL BIOMEDICAL RESEARCH INSTITUTE AMONG THE UNIVERSITY OF MAINE SYSTEM AND MAINE'S NOT-FOR-PROFIT BIOMEDICAL RESEARCH LABORATORIES

Purpose

This Appendix outlines a plan to form a Virtual Biomedical Research Institute, linking the University of Maine System with not-for-profit research laboratories in Maine. The purpose of the Institute is to develop more broadly based, world-class activity in biomedical science and associated fields, and graduate education in Maine

Rationale

Future trends and developments in biomedical research provide excellent opportunities for Maine to move toward its goal of increasing average personal incomes of Maine citizens. Federal expenditures for biomedical research already exceed all non-military R&D expenditures and are expected to double over the next five years. Acting National Institutes of Health (NIH) Director Ruth Kirschstein is actively promoting "…the need for a continued, very deep support for biomedical research and for all aspects of the biological and physical sciences that surround it". In addition, she is prepared to reward intrastate collaboratives.

The NIH is aware that the scientific challenges inherent in determining gene function require an interdisciplinary approach involving state of the art biosciences, physics, chemistry, engineering and informatics. Collectively, researchers at institutions throughout the State of Maine have significant expertise that can be applied to the development of new, more effective tools for biomedical research.

To allow Maine to capture a larger portion of the federal R&D funds available for biomedical research, however, we must develop a mechanism that takes advantage of this collective expertise to (1) leverage significant additional talent and infrastructure, (2) increase research capabilities and opportunities for all participants, and (3) provide outstanding opportunities for students.

A virtual Biomedical Research Institute with statewide Centers of Excellence is a mechanism to accomplish these objectives.

Overview

The Biomedical Research Institute will be a public-private partnership between the University of Maine System and not-for-profit research institutions in Maine. It will foster an interdisciplinary, collaborative approach to biomedical research, involving experts in biomedicine-related and associated scientific fields and will draw on expertise and research infrastructure from institutions throughout the State. The Institute will focus on use-inspired basic and applied research and related graduate level education in specific areas defined as Centers of Excellence within the Institute. Areas of intersection between biomedicine and other technologies targeted in the State Science and Technology Plan are appropriate foci for Centers of Excellence.

The Biomedical Research Institute will be a formally recognized joint venture among the University of Maine System and other institutions throughout the State. The graduate program portion of the joint venture will be housed at the University of Maine with the full membership of qualified investigators at participating institutions.

Governance & Management

The Institute will report to the Chancellor of the University of Maine System. It will have a director chosen from a participating institution who is responsible for routine administration; a University of Maine faculty member will direct the graduate program.

A Board of Directors composed of research leaders from the major participating institutions will be responsible for (1) establishing membership criteria and performance requirements, (2) establishing Centers of Excellence that reflect mutual interests and opportunities of the participating institutions, (3) administering the Institute's overall performance review on a regular basis, and (4) promoting the Institute locally, nationally and internationally. It will advise the Director and Chancellor on new opportunities, and assist with problem solving.

Centers of Excellence will be the effector mechanism for the Institute. Initially, the Board of Directors will designate three to five Centers of Excellence. Specific centers will be determined by need, critical mass, opportunity for external funding, synergy with institutional strategic plans. Potential centers include Genomics, Biophysics-Bioengineering & Biomaterials, Bioinformatics (biomedicine and information technology), Outcomes and Health Services, and Marine Biomedicine. More Centers may be added as needs are identified by the Board. It is expected that centers will be initiated at different states of maturity and financial requirements.

Each Center will have a director, who will be a participating research scientist and will be responsible for routine administration of the Center. Center directors may be employed by any of the participating institutions, or may hold joint appointments at multiple institutions. Center directors will serve 3-year renewable terms.

Each Center will have an external Scientific Advisory Board to help guide the research agenda and to facilitate regular programmatic reviews. Research proposals by Center members will be submitted under the auspices of the Principle Investigator's home institution, with subcontracts to other institutions as appropriate.

Faculty of each Center will develop curriculum and research requirements for Center-specific Ph.D. programs. Until the UMS Board of Trustees approves those programs, graduate programs will be delivered through the University of Maine's individualized Ph.D. program. Center faculty will be responsible for setting appropriately competitive stipend levels, accepting graduate students, and awarding fellowships for their Center's program.

Members of the Institute will hold joint appointments with their home institution (or UM department, in the case of UM participants) and with the Biomedical Research Institute. Non university investigators will be full members of the UM graduate faculty and have equal say as UM employees in all matters concerning research and curriculum development. Promotion and tenure decisions affecting UM members will be handled by joint committees of the Institute and their departmental home, as is currently done for members of other organized research units on campus.

Central office space will be provided by UMS. The Institute will have an annual budget guaranteed by the university to cover defined managerial and operational costs. Research instrumentation owned by and located at other participating institutions will also be made available to members within conditions defined by those institutions. The Institute and Centers of Excellence will be promoted externally as a cohesive entity, including all distributed but available research infrastructure.

Centers may use funding to support existing faculty or to recruit new researchers.

Goals & Objectives

1. Develop a long-term, stable mechanism to enhance biomedical research and graduate education at institutions throughout the state.
    a. Establish officially recognized research entity composed of members from multiple institutions.
    b. Develop appropriate articulation agreement(s) between UMS and institutions of participating members.
    c. Attract and retain high caliber graduate students by offering competitive stipends and by recruiting aggressively.
    d. Develop high-speed telecommunications and teleconferencing capabilities among institutions of participating members.
    e. Develop shared library resources among institutions of participating members.
2. Establish new competencies in biomedical related fields of science and engineering.
    a. Designate and develop 3-5 Centers of Research Excellence in biomedical related and associated fields.
    b. Identify and develop additional Centers through member discussion and analysis.
    c. Build significant and appropriate shared research infrastructure.
3. Become a nationally recognized leader in biomedical science and engineering research and graduate education.
    a. Attract and retain world leaders in fields related to bioscience.
    b. Attract significantly increased federal funding for biomedical research.
    c. Promote capabilities to a global scientific audience.

Benefits

This initiative will benefit Maine citizens by significantly increasing federal per capita R&D expenditures, a primary goal of the "30 & 1000 Plan" to improve average income levels in Maine. It will also result in new technologies and applications of commercial value that lead to new job opportunities for Maine people. Over time, this initiative will create one of the magnets needed to retain Maine's college bound high school graduates, attract talent from elsewhere, and to increase percentages of Maine citizens with a 4-year college degree.

Benefits for participants will include increased opportunities to mentor high-quality graduate students, increased access to state-of-the-art physical infrastructure, increased competitiveness for federal grants and contracts, increased opportunities for collaborative research, and enhancement of the intellectual atmosphere. These benefits will be broadly felt throughout each participant's organization.

Expenses of Prototypical Centers of Excellence

Space	Provided by participating institutions.
Equipment	Owned, housed, and operated by participating institutions. Made available to members to the extent possible in light of other institutional obligations. New research instrumentation will be sought through competitive grants from funding agencies. Institutions collaborating on those grants will supply any required matching funds.
Director salary	1 position. 50% paid by Center, 50% by home institution
Faculty salary	6 positions. 50% paid by Center, 50% by home institution
Administrative support	1 Administrative Secretary paid by Center
Graduate student support	6 positions paid by Center
Postdoctoral Fellow support	3 positions paid by Center
Support for minor equipment and supply allocation, expenses for the Scientific Advisory Committee, and program expenses, such as seminars, program support, etc., paid by Center	
Estimated cost per Center of Excellence	$2 million per Biennium

Other Issues

- The Institute and Centers of Excellence will cooperate with the newly established Incubators and with the MTI.
- The Institute's Board of Directors will determine criteria for membership in the Centers; Center of Excellence performance criteria will be determined by the Center leadership and it's External Scientific Advisory Board, and approved by the Institute.
- Prior to the legislative session, research leaders from UMS and the research institutes will convene to form the Institute, designate the Centers, determine eligibility criteria, and select directors and lead organizations. Subsequently, Center membership, Advisory Committee, and performance criteria will be established.

APPENDIX D
DEFINITIONS AND METRICS

THE DEFINITION OF "R&D" EXPENDITURES: The dollar figures used in this memorandum are from the National Science Foundation, which maintains comparable figures for each state. They include actual funds spent on basic research, applied research, and development of technologies, products, and processes. They do not include figures that might be related to R&D -- such as funds for instruction, for the general support of science and technology, or for building projects that might benefit R&D activities but are not specifically for the support of R&D as the primary purpose. Thus, Maine is spending more than 0.49% of GSP, and more than $238 per employed worker, on science and technology activities (and the average state is spending more than 2.61% of GSP). But the focus here is on that part of science and technology that represents expenditures for actual research and development. Because these figures are available from NSF for all states, comparisons and models based on the data are possible.

OTHER METRICS RELATED TO R&D IN MAINE

- Industry performed research -- total basic, applied and development by industry (1998 Maine ranked #41 and was at $2.54 with national median at $14.26/$1000 in GSP)

- SBIR Awards -- number of SBIR awards made (1996-8 Maine averaged 6/year which ranked Maine #37 with score of 1.7 while national median was 3.0/10,000 establishments)

- Technology Intensive Establishments -- % of establishments that are within 28 3-digit SIC high technology codes (1996 Maine ranked #38 with 3.5%, as compared to median of 5% nationally, of establishments being high tech)

- Technology Intensive Employment -- % of employment within 28 3-digit SIC high technology codes (1996 Maine ranked #40 with 4.4%, as compared to median of 7.2% nationally, of employment in high tech establishments)

- Technology Establishment Births -- % of new all new establishments that are high tech (1996 Maine ranked #34 with 4.9%, as compared to median of 5.7% nationally, of high tech establishments created)

- Total Performed R&D Expenditures -- total basic, applied and development research from all sources (1998 Maine was at $159 million which ranked us #45 -- median score of $/$1000 GSP was $17.54 with Maine at $4.93)

- University performed research -- total basic, applied and development by universities and colleges from all sources (1998 Maine ranked #50, was at $35 million with a national median of $2.81/$1,000 in GSP -- Maine was at $1.09)